U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

NOISE CERTIFICATION HANDBOOK

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Federal Aviation Administration

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FOREWORD

The aim of this technical manual is to promote uniformity of implementation of the noise certification requirements of Part 36 of the Federal Aviation Regulations (FAR) by presenting test, analysis, and documentation procedures for subsonic turbojet airplanes that have been determined by the FAA to be technically acceptable for demonstrating compliance with that regulation. Where appropriate, FAA policy governing such certifications is reviewed.

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CHAPTER 1. GENERAL

1. PURPOSE. The aim of this advisory circular (AC) is to promote uniformity of implementation of the noise certification requirements of Part 36 of the Federal Aviation Regulations (FAR) by presenting technically acceptable test, analysis and documentation procedures for subsonic turbojet airplanes that may be used by applicants for demonstrating compliance with Part 36. Where appropriate, FAA policy governing such certifications is reviewed.

2. CANCELLATION. Advisory Circular 36-4A, Noise Certification Test and Analysis Procedures, dated January 21, 1986, is cancelled.

3. BACKGROUND. Part 36 contains noise certification standards for turbojets, large transport category airplanes, and propeller-driven small airplanes. These regulations require that standard procedures be used unless an equivalent procedure is approved by the FAA. However, airplane noise measurement and analysis technology has developed considerably since Part 36 was adopted in 1969. Through aircraft noise certification, a body of technically sophisticated measurement and analysis methods has been developed by certificate applicants. As a result of this experience, alternative compliance methods have evolved and have been approved by the FAA. This AC describes those procedures. Applicants should always obtain prior approval from the responsible FAA certificating official before initiating any noise certification action. It should also be noted that the methods presented in this AC are not the only ways to demonstrate compliance with Part 36 nor the only ones that may be approved in the future.

4. OBJECTIVE. The objective of noise certification is the demonstration of compliance with Part 36 for one or more specific airplane versions. The demonstration method used to determine noise levels will depend upon a number of factors. For example, Part 36 requires an applicant for a new type design to conduct a noise demonstration flight test. However, depending upon the extent of the data already in existence for the type design, the applicant for a change to an existing type design may submit for FAA approval a proposal either to conduct a flight test or to conduct supplementary tests and/or analyses. When supplementary data are used, they serve as the basis to adjust flight noise levels already approved for an earlier version. Dialogue between the applicant and the certificating authority at the beginning of an airplane certification program is necessary to identify anticipated changes in airplane type design that can impact noise certification. A noise compliance demonstration plan outlining the planned tests and/or analyses should be submitted as soon as possible to the FAA by the applicant. This plan should contain the method by which the applicant proposes to show compliance with the noise certification requirements. Because of the unique nature of each noise demonstration, the test plan is reviewed with the certificating authority before each test and, if necessary, modified to reflect any unique aspects or current developments related to the immediate noise demonstration test. With this flexibility, a single test plan, submitted to encompass more than the immediate test, is often advantageous. Guidance on preparation of noise compliance demonstration plans and certification compliance data reports is provided in Chapter 4 of this AC.

5. NOISE DEMONSTRATIONS.

a. Flight Tests. This AC presents guidelines on methods to acquire noise data from a sufficient number of flights of a particular airplane to derive the three required Effective Perceived Noise Level (EPNL) levels. Guidelines are also provided on acquisition and normalization methods such that a generalized noise data base (defined by noise-power-distance relationships) may be developed for an airplane type. Suggested procedures for determining the certificated Part 36 noise levels derived from this generalized noise data base are also provided. This generalized data base is directly applicable to changes in type design which retain the same basic noise source characteristics.

b. Supplemental Noise Demonstration Methods. For those applicants seeking approval for changes in type design, guidance is also provided on suggested procedures for determining noise level changes relative to a previously approved version of the type. These procedures rely on supplementary testing and/or analysis techniques in conjunction with approved noise data already available for the type. The use of such methods for demonstrating noise compliance is optional, subject to FAA approval, and does not preclude an applicant from using a flight test for each noise certification demonstration.

c. Changes To Noise Certification Levels For Derivative Versions. Many of the equivalent procedures given in this AC relate to derivative versions, where the procedure used yields the information needed to obtain the noise certification levels of the derivative version by adjustment of the noise levels of the "flight datum" aircraft (i.e., the most appropriate aircraft for which the noise levels were measured during an approved Part 36 flight test demonstration). The physical differences between the "flight datum" aircraft and the derivative version can take many forms, for example, an increased takeoff weight, an increased engine thrust, changed powerplant or propeller types, etc. Some of these changes will alter the distance between the aircraft and the noise certification reference points, others the noise source characteristics. Procedures used in the determination of the noise certification levels of the derived versions will, therefore, depend upon the change to the aircraft being considered. However, where several similar changes are being made, for example, introduction of engines from different manufacturers, the procedures used to obtain the noise certification levels of each derivative aircraft should be followed in identical fashion.

6. WITNESSING OF TESTS. All flight and other tests conducted in support of noise certification need to be witnessed by FAA personnel or by an Acoustic Designated Engineering Representative (DER) appointed under Order 8110.37. Under that Order, Acoustic DER's may:

- Witness and approve noise certification tests conducted in accordance with an approved test program, when specifically authorized to do so by the FAA.

- Approve noise analysis techniques and computer programs and certify the noise values reduced by these programs that were measured and evaluated as prescribed in Subparts B and/or F of Part 36 or by an equivalent procedure previously approved for that noise test series by the Office of Environment and Energy.

Prior FAA approval is required for the re-delegation by Acoustic DER's of the authority to witness tests. In addition, Acoustic DER's may not determine whether a type design change is an acoustic change under Part 21. Acoustical DER's also may not approve:

- Test plans or equivalent procedures,

- Operating limitations or other Aircraft Flight Manual information, or

- Certificated aircraft noise levels.

7. [RESERVED]

CHAPTER 2. NOISE DEMONSTRATION FLIGHT TEST UNDER PART 36 APPENDICES A AND B

8. TEST CONDITIONS. The airplane should be operated such that noise values corresponding to the takeoff, sideline, and approach reference conditions defined in Part 36 can be derived within the limitations of Appendix 1. To meet the test environmental requirements prescribed in Part 36, the following test site and atmospheric conditions have been approved as providing an acceptable test environment.

a. Test Site Characteristics. The noise measurement stations are placed such that the reference locations specified in Part 36 can be adequately simulated. Part 36 prescribes reference noise measurement stations relative to runway brake release or threshold point (e.g., 6500 meters from brake release for takeoff measurements); however, actual test measurement station locations may differ for the following reasons:

(1) To minimize the impact of ambient sound on the measurement of the airplane sound pressure levels. Prior to testing, a comparison of expected airplane sound pressure levels with the expected test-site ambient sound will aid in choosing test microphone locations. It is generally preferable to relocate measurement stations rather than contaminate airplane noise measurements with ambient sound from sources such as nearby road or air traffic.

(2) To increase the airplane signal-to-noise ratio to ensure adequate measurement of the airplane's acoustic signature. In such cases, the takeoff measurement station and/or the airplane flight trajectory may be relocated so that the test day sound propagation path length is less than the reference path length to ensure acquisition of acceptable data. In the selection of an adequate signal-to-noise ratio, consideration should be given to limitations on corrections for the influence of ambient sound, as well as limitations on the total correction from test to reference conditions.

(3) When obstructions near the noise measurement station(s) will influence sound measurements. Takeoff and approach measurement stations may be relocated as necessary to avoid undesirable obstructions. Sideline measurement stations (distances) may be relocated by distances which are of the same order of magnitude as the airplane lateral deviations (or offsets) relative to the nominal flight path that occur during flight testing.

NOTE: Flight path intercepts adopted as alternatives to full takeoffs and full stop landings may be adjusted to attain the same performance as would be observed at the reference distances.

b. Atmospheric Conditions.

(1) Temperature and Relative Humidity Limits. When atmospheric conditions of ambient temperature and relative humidity result in atmospheric absorption in the 8 kHz one-third octave band at any point along the sound propagation path exceeding 12 dB/100 m, then instrumentation used to determine relative humidity should consist of an ambient air temperature and dew point

temperature measurement system accurate to within ± 0.5°C. When such instrumentation is used, the 8 kHz atmospheric absorption may be extended to 14 dB/100 m and, for approaches only, to 16 dB/100 m. Relative humidity is required to be between 10 and 95 percent.

(2) Wind Limits. Testing may be conducted when: the wind speed does not exceed an average value, over the sound measurement period, of 12 kts and a maximum value of 15 kts; the crosswind component does not exceed an average value over the sound measurement period, of 7 kts and a maximum value of 10 kts. A 30 second moving average is used to define average wind speed. Part 36 requires the wind measurements to be made 10 meters above the ground and in the vicinity of the measuring station.

9. FLIGHT PROCEDURES.

a. Selection of a Flight Test Noise Demonstration Method. An accurate, reliable definition of the airplane noise characteristics is the primary objective of the demonstration test. To achieve this goal, at least six sound measurements are required by section A36.5(e) and section 8(a)of Part 36 to ensure that a mean noise level for each of the three certification reference conditions can be defined with a 90 percent confidence interval not exceeding ± 1.5 EPNdB. This requirement can be achieved by conducting a series of test flights at or near reference power. After adjusting each measured noise level to Part 36 reference conditions, a certification noise value should be computed by averaging the adjusted levels (see paragraph 14). An alternate method is to acquire sufficient measurements (at least six) to allow the generalized noise characteristics of the airplane to be developed (a noise-power-distance data base (NPD)). (See paragraph 14(e)(2)). The three certification levels for any specific configuration are then determined by entering the developed data base at the certification reference distance and power and applying appropriate airplane speed corrections.

(1) For a range of powers covering full and cutback powers, the airplane is flown past sideline and under-flight-path microphones in accordance with section C36.3 of Part 36. Sufficient noise measurements are made to enable noise-power curves at a given distance for both sideline and takeoff cases to be established. These curves are extended either by calculation or by the use of additional flight test data to cover a range of takeoff distances to form the generalized noise NPD data base for use in the noise certification of the "flight datum" and derived versions of the type. The 90 percent confidence intervals about the mean lines are constructed through the data. This sequence should be repeated for an under-flight-path microphone for a range of approach powers using the appropriate speed and airplane configuration. In compliance with section C36.9 of Part 36, the approach configuration that is most critical from a noise standpoint must be used. When in doubt, an applicant may be required to test and evaluate more than one configuration.

(2) When approved data are available to define the engine spool down characteristics, it may be appropriate to substantiate noise levels for cutback power without the implementation of a cutback takeoff procedure by making noise measurements during reduced power operations. The average engine

spool down time should be representative of average conditions and should reflect a 1.0 second minimum altitude-recognition lag time to account for pilot response. For determination of the reference cutback noise levels, the cutback initiation should be selected to ensure stabilized cutback power conditions before the initial 10 Tone Corrected Perceived Noise Level (PNLT) down point. Flyover noise levels with power cutback may be established from the merging of PNLT versus time measurements obtained during constant power operations. As seen in Figure 1(a), the 10 dB down PNLT noise time history may contain portions of both the full power and cutback power noise time histories. Provided these noise time histories, the average engine spool-down thrust characteristics and the airplane flight path during this period (Figure 1(b)), which includes the transition from full to cutback power, are known, the flyover noise level may be completed.

(3) An alternate method may be used to derive cutback power noise levels. In some cases, this method results in lower EPNL values, depending upon the characteristics of the forward radiated noise. Actual test runs may be conducted using a power cutback procedure that is initiated close to the overhead point. This technique is different from the procedure described in the previous paragraph in that the engine power is not stabilized during the entire 10 dB down time period. The concept involves delaying power cutback in order to gain extra altitude, but cutting back power before the maximum PNLT (PNLTM) exceeds the PNLTM that would exist using stabilized cutback power. Since this is a more difficult flight test procedure, care should be exercised in conducting the test runs to ensure consistency in order to meet the 90 percent confidence interval criteria.

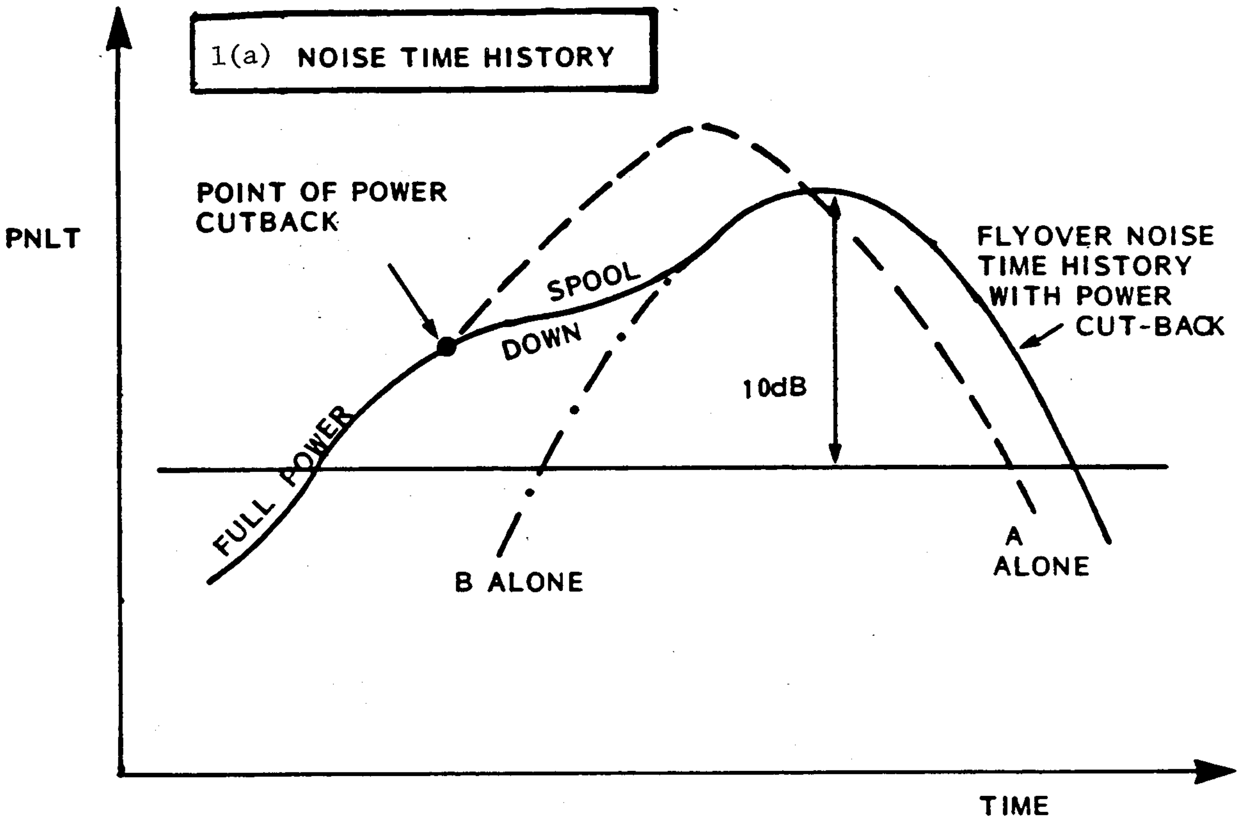
(4) The airplane's source noise characteristics should be measured over the operating range in sufficient detail to define the difference between test and reference day source noise. To aid in obtaining adequate data for these adjustments it may be necessary to identify those airplane/engine parameters, e.g., N_1 / θ_{t2} for turbofans, that are the major controllers of the airplane's noise level and appropriately vary these parameters during the test. For propeller-driven airplanes, the engine parameters are propeller helical tip Mach number and shaft horsepower.

b. Nominal Conditions for Development of a Reference Noise-Power-Distance Data Base (NPD). For the development of a generalized NPD, sound pressure level (SPL) data are normalized to the ambient environmental conditions specified in Part 36 and to nominal takeoff and approach aerodynamic configurations and performance. For example, the selected airplane speed should be representative of the range of speeds for the configurations and weights which are anticipated to be certified. In addition, takeoff and approach configurations may be different; requiring normalizing SPL data to different airplane speeds. Note that the adjustment procedure requires FAA approval when developing an NPD. (See paragraph 14(e) of this AC.) An example of a generalized NPD is shown in Figure 2.

c. Measurements at Non-reference Points. In some instances test measurement points may differ from the reference measurement points in Part 36, Appendix C. Under these circumstances an applicant may request

FIGURE 1

COMPUTATION OF CUTBACK-TAKEOFF NOISE LEVEL FROM CONSTANT POWER TESTS



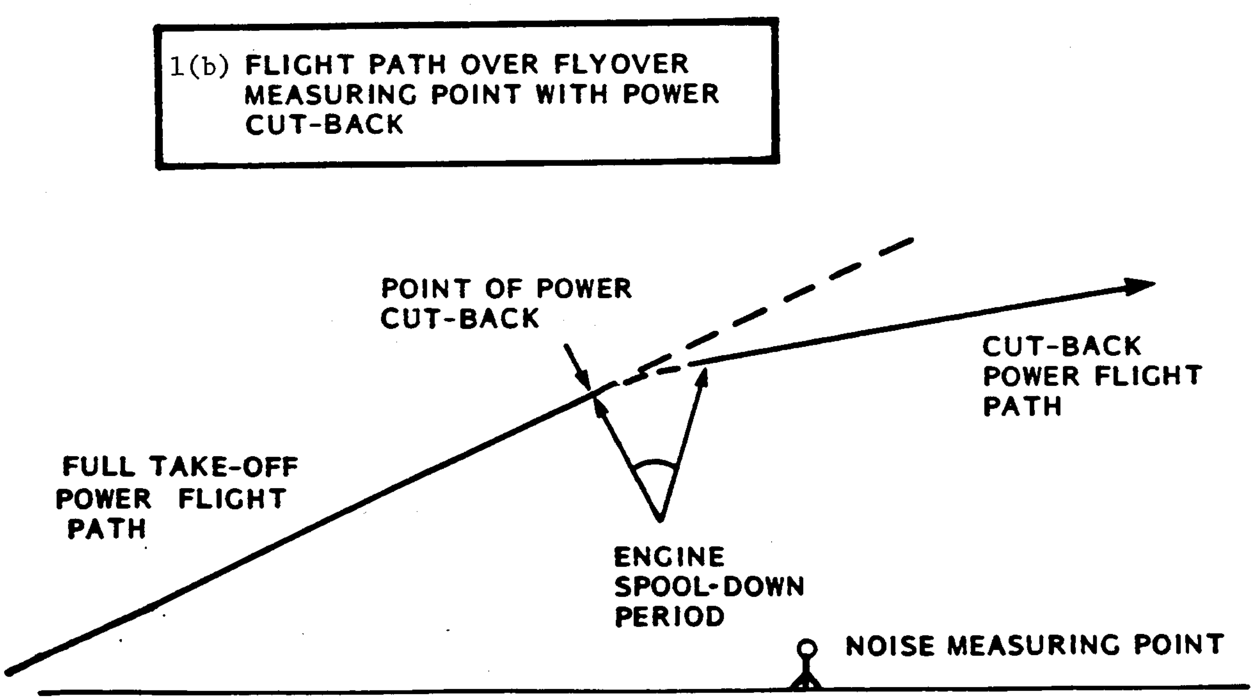
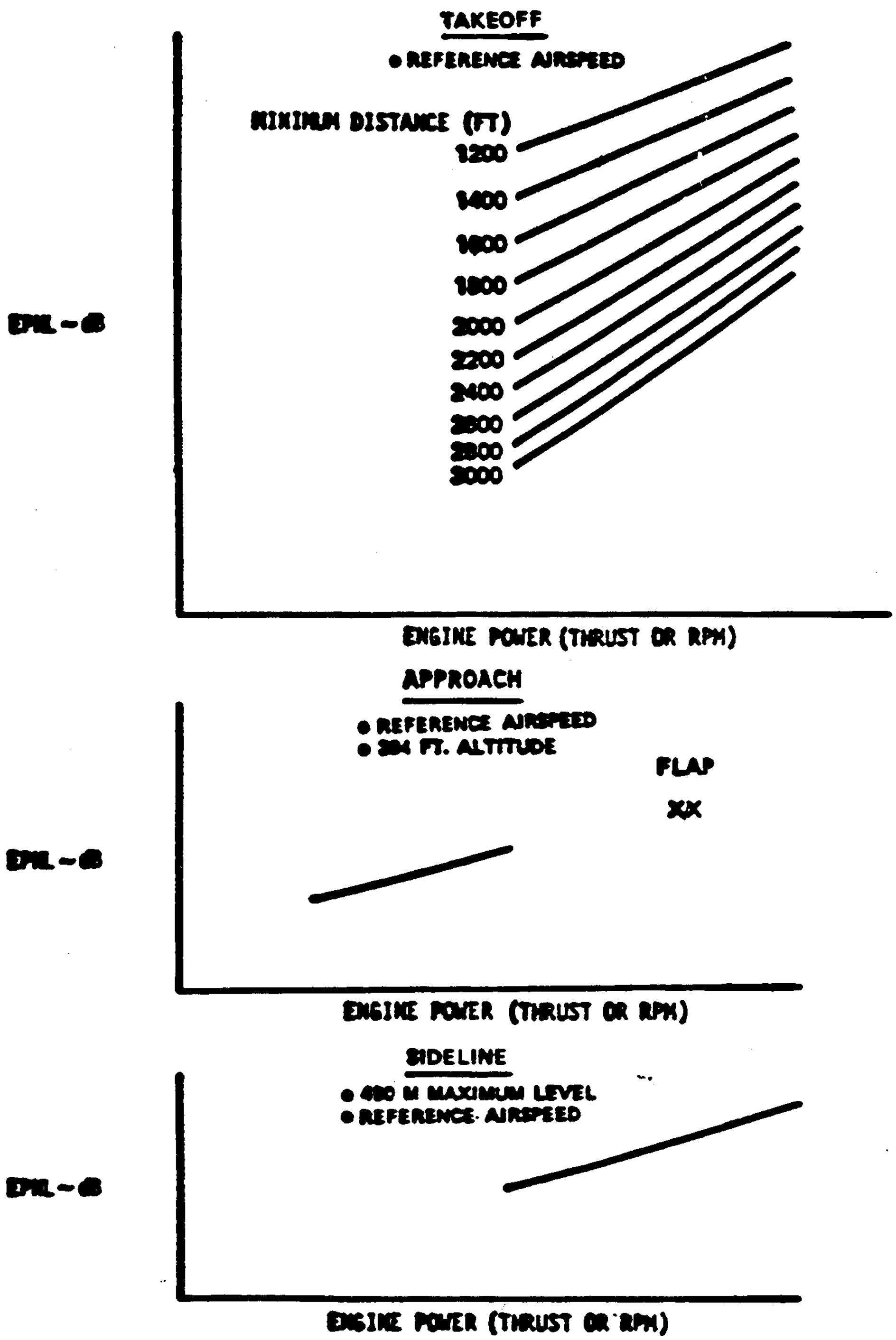


FIGURE 2

EXAMPLE OF GENERALIZED NOISE POWER DISTANCE DATA BASE



approval of data that have been adjusted from the actual measurements to represent data that would have been measured at the reference points in reference conditions. (See paragraph 8(a).) Reasons for such a request may be:

(1) to allow the use of a measurement location that is closer to the airplane flight path so as to improve data quality by obtaining a greater ratio of signal to background noise;

(2) to enable the use of an existing, approved certification data base for an airplane type design in the certification of a derivative of that type when the derivative is to be certificated under reference conditions that differ from the original type certification reference conditions;

(3) to avoid obstructions near the noise measurement station(s) which could influence sound measurements. By using a flight path intercept technique, takeoff and approach noise measurement stations may be located as necessary to avoid undesirable obstructions. Sideline measurement stations may be relocated by distances which are of the same order of magnitude as the airplane lateral deviations (or offsets) relative to the nominal flight paths that occur during flight testing. Approval has been granted to applicants for the use of data from non-reference noise measurement points provided that measured data are adjusted to reference conditions in accordance with the requirements and limitations of Part 36, Appendices A and B.

d. Test Day Flight Procedures. Airplane weight and flight trajectory can be properly simulated by controlling those parameters most directly related to the airplane/engine noise source strength and directivity. Test day flight procedures should be chosen to provide an adequate definition of the airplane noise source characteristics. The selection of test day flight procedures will depend upon the methodology chosen to derive certification noise levels, i.e., either by repeating the reference conditions or from an NPD.

(1) Test Day Procedures. Selection of test day flight procedures should be compatible with the methodology chosen to derive certification noise levels. If an applicant chooses to derive certification noise levels by averaging at least six conditions flown at or near reference power and distance, then corrections should account for differences in airplane source noise between test and reference airplane power settings. To qualify these corrections, testing at other operating conditions may be required to define in sufficient detail the airplane source noise levels. This testing may be in addition to the number of measurements at or near reference power necessary to achieve a 90 percent confidence interval not exceeding $\pm$ 1.5 EPNdB. The applicant may, however, choose to derive the certification noise level directly from a generalized NPD. The NPD is developed by conducting a sufficient number of sound measurements over a range of airplane operating conditions so that the 90 percent confidence interval about a mean line does not exceed $\pm$ 1.5 EPNdB. To describe a power line an applicant should conduct a minimum of six flights, each at a different power setting, at a common target altitude. To attain the required confidence interval, more than six flights may be necessary. Typically, the power-related parameter which governs noise generation is corrected low pressure rotor speed, $N_1/\sqrt{\theta_{t2}}$, corrected net thrust, Fn/δ_{amb}, or EPR, where:

N_1 is the actual low pressure rotor speed,

θ_{t2} is the ratio of absolute total temperature of the air at the height of the airplane to the absolute temperature of the air for an international standard atmosphere (ISA) at mean sea level (i.e., 288.15°K)

EPR is engine pressure ratio.

F_n is the actual engine net thrust per engine, and

δ_{amb} is the ratio of absolute static pressure of the ambient air at the height of the airplane to ISA air pressure at mean sea level (i.e., 29.92 in HgA or 101.325 kPa).

(2) Simulated Takeoffs and Approaches. Where shown by the applicant to be equivalent to the procedures specified in Part 36, simulated takeoffs and approaches, consisting of flight path intercepts may be used in lieu of starting and ending each flight from a full stop. For takeoff, flight path intercepts consist of intercepting and following the desired climb profile beginning at a target distance above ground level. Approach intercepts maintain the approach path over the measurement location without actually landing. In either case, the airplane is stabilized and following the target trajectory throughout the sound measurement period. (The sound measurement period includes levels within 10 PNdB below the maximum.) Test airplane weights, speeds, and aerodynamic configurations should be selected to allow achieving target test conditions for those performance parameters having the major effect on noise generation. Approved inflight operable Auxiliary Power Units (APU's) must be on during all approach test conditions.

e. Target Test Conditions. Target test conditions can be established for each sound measurement. These target test conditions will define the selected aerodynamic configuration, airplane weight, flight procedure (such as takeoff flight path intercept), altitude, power, and airspeed at the closest point of approach to the measurement location. For example, a takeoff aerodynamic configuration may be defined by the climb gradient and flap setting. NOTE: The airplane angle of attack will remain approximately constant for all weights if the tests are conducted at a constant flap setting and the airplane speeds correspond to the reference speed, V_2 + 10 kts for each weight. The aerodynamic configuration, e.g., flap setting, must remain constant during the sound measurement period. Speed corrections, however, are generally permitted up to 15 kts. Alternatively, for many airplanes the airplane attitude remains approximately constant for all weights if the tests are conducted at the V_2 + 10 kts for the maximum takeoff weight. In the execution of the flight for purposes of obtaining sound measurements, the pilot should "set up" the airplane with the selected configuration in order to pass by the measurement location at the target altitude, power, and airspeed.

10. MEASUREMENTS. This section provides guidelines on how to obtain sound measurements and relevant airplane position and performance data necessary for normalizing the measured sound data to conditions differing from the actual test day conditions. All of these are synchronized.

a. Sound Measurements.

(1) All sound measurements are made with equipment meeting the specification in Part 36. The measurements are made such that, when processed, they will provide one-third octave band sound pressure levels as a function of time for the calculation of EPNL.

(2) The location of each noise measuring station must be surrounded by relatively flat terrain having no excessive sound absorption characteristics, such as tall (in excess of 3 inches) grass, shrubs, or wooded areas. For measurement sites located on the extended runway centerline, a closely mowed grass circle 50 feet in diameter is acceptable. For sideline locations, the grass may be mowed in a 50-foot semicircle facing the line of flight. Any earthen or sandy surface should be reasonably tamped down. Plowed furrows, silt, or soft powdered surfaces are unacceptable. In the winter time, a 50-foot radius microphone area that is clear of snow may be considered acceptable by the onsite FAA witness when other weather restrictions are acceptable.

(3) Microphones should be located at the certification reference height of 1.2 m (4 ft) above the ground surface. In some cases, such as for pseudotone identification, it may be desirable to obtain additional data exhibiting free-field spectral shapes by selecting a microphone location to minimize the interference effects of ground reflections on the measured sound spectra (see Appendix 3 of this AC). Free field spectral shapes can be obtained by:

(a) mounting the microphone high above the ground so that the first interference frequency falls below the range of interest. A height of 10 m (33 ft) is generally adequate.

(b) mounting the microphone diaphragm in the plane of, or very close to, a large, acoustically hard (reflective) ground-plane surface so that the direct and reflected waves arrive in phase causing a doubling of the sound pressure. Care must be taken to ensure that the hard surface does not have air pockets beneath the surface or edges that could influence the acoustic measurements.

(4) Orientation of the microphone will depend on the microphone type. Most commonly used are grazing incidence microphones which are designed so that nearly a flat frequency response is maintained at grazing incidence to the microphone; the microphone is oriented to maintain near grazing incidence throughout the airplane flyover. Perpendicular incidence microphones are designed so that maximum sensitivity occurs when they are oriented so that the sound impinges upon the diaphragm in a perpendicular direction when the airplane is at the closest point of approach. Data obtained using perpendicular incidence microphone are acceptable provided that the data are corrected for directivity and frequency response effects and the maximum Noy value for the corrected data is located in the one-third octave band centered at 5000 Hz or less.

(5) If the airplane sound pressure levels within the sound measurement period do not exceed the background sound pressure levels by at least 10 dB in each one-third octave band, they may be adjusted to eliminate the additive influence of the background sound. When the airplane sound is less than 10 dB, but more than 3 dB above the background, the corrected airplane sound levels are obtained by logarithmically subtracting the background sound levels. For those situations where the airplane levels are less than 5 dB above the background, this influence may be avoided by obtaining measurements at distances closer to the airplane and then adjusting the measurement to the desired distance or by adjusting the measured sound pressure levels using technically supported analytical shaping methods (see Appendix 2 of this AC). NOTE: If the measurements are not adjusted to delete background noise, the resultant EPNL values will be higher than if measured in the absence of background noise.

(6) Maximum sideline noise may be determined by positioning several measurement stations parallel to the airplane flight track as prescribed in Part 36. An alternative to this method may be to use two measurement stations, symmetrically positioned about the nominal flight track, and fly the airplane at several altitudes and thus simulate the data that would have been acquired during a "climb-out" using a series of measurement stations. Experience suggests that the maximum noise level will occur at an elevation angle near 34 degrees (approximately 1000 ft altitude for airplanes with 1,476 feet [450 meter] sideline measuring stations) and the levels will be rather insensitive within several degrees of this value. When the two-station method is used, the sideline noise for each run is the arithmetic average of the corrected EPNL from each of the two lateral measurement points. The confidence level should be calculated using the method in Appendix 5 (paragraph 2 of this AC).

b. Airplane Position and Performance.

(1) The airplane height and lateral position relative to a fixed location (the nominal flight track along the extended centerline of the runway) should be determined by a method independent of normal flight deck instrumentation. Methods found to be acceptable include radar tracking, theodolite triangulation, laser trajectography, microwave positioning, and photographic scaling techniques (when the simplified method is used). Care must be taken when the photographic scaling technique is used to ensure that the airplane position can be reliably related to the sound measurement positions. In the past, inaccuracies in space positioning have been introduced by using hand-held cameras to take single photographs of aircraft supposedly overhead. The aircraft are often off-center from the reference flight path. Firm mounting on a fixed tripod can eliminate some of the sources of possible error The simplified method for correcting EPNL should be used when continuous tracking is not available.

(2) The airplane position along the flight path can be related to the sound pressure levels recorded at the measurement locations by using synchronized signals. Airplane position should be recorded during the sound measurement period.

(3) Measurements of airplane/engine performance parameters for calculation of test day performance should be recorded throughout the sound measurement period. These measurements should be time-related to the airplane position along the flight path. Examples of parameters for measurement are airplane attitude, engine power setting, climb angle, and airplane speed. Flap position and gear position should be fixed and noted for each test condition.

11. SOUND MEASUREMENT SYSTEM SPECIFICATIONS. The noise certification test should use a quality sound measurement system. Output should be measured in the form of one-third octave band sound pressure levels covering the frequency range from 45 Hz to 11,200 Hz for each one-half second over the sound measurement period. Included in the measurement system should be components that perform the following functions: transform sound pressure waves to electrical signals (microphones), condition the signals, store signals for later analysis, and retrieve and analyze the signals in terms of one-third octave band levels as a function of time.

a. Corrections to compensate for instrumentation non-uniform frequency response characteristics should be determined and applied to the sound pressure level data. These should include response characteristics of (a) microphone free field and directivity, (b) windscreen insertion loss and directivity, (c) preemphasis, (d) signal conditioning equipment, (e) data storage and retrieval system, and (f) analysis system. All corrections should be identified, documented, and FAA approved.

b. When selecting sound measurement system components, compliance with requirements may be determined from manufacturers' specifications, user calibrations, or a combination of both. When multiple systems of the same type are used, demonstration of compliance of at least one system is satisfactory. However, this does not preclude the need to perform the system calibrations and checks described in Part 36 and paragraph 13 of this AC. Analysis systems that meet the specifications defined in the following paragraphs have been approved.

12. ANALYSIS SYSTEM. The analysis system may be either analog or digital and provide a root mean square (RMS) sound pressure level in one-half second increments in each of the 24 one-third octave bands having geometric mean frequencies from 50 Hz to 10 kHz. The averaging properties of the integrator may correspond to one of the following:

a. For instruments with exponential averaging characteristics, the requirements for Type 1 sound level meter with "slow" response as defined in International Electrotechnical Commission (IEC) Publication No. 651.

b. For true integrating instruments compliance with the "slow" response as defined in IEC 651 may be demonstrated by combining successive readouts from the data processor, such as -3, 0, +1 half-second samples or -2, 0, +2 half-second samples. This combination of readouts is required since the effective "slow" response averaging time is greater than the sampling interval. When a true integration system is used, an acceptable alternative to combining "successive" readouts is to set the integration time equal to the sampling interval. The use of this type of data reduction system has required the use of the integrated EPNL method.

13. SOUND MEASUREMENT EQUIPMENT CALIBRATIONS AND SYSTEM CHECKS. Part 36 requires calibration of the sound measurement system. This section describes approved procedures to calibrate and check the complete measurement system. These procedures provide guidance which ensures proper equipment performance over the frequency range from 45 Hz to 11.2 kHz.

a. Frequency Response.

(1) The free-field frequency response characteristics of each microphone are determined by a pressure response calibration (which may be obtained from an electrostatic calibrator) in combination with manufacturer provided corrections or by a free-field calibration in an anechoic facility. The directivity response characteristics of the microphone need to be defined and cover a sufficient angular range to encompass the sound measurement period.

(2) Within 5 days of test the electrical response characteristics of each measurement system, excluding the microphone and windscreen, should be determined at a level within 10 dB of the full-scale reading used during the test, using one of the following input signals: sine waves at the center frequency of each one-third octave band, or pink noise. Sufficient determinations are made to ensure that the overall calibration of the system is known for each test. The calibration signal generator should have been checked within 6 months of the test series with instruments which meet standards set by the National Bureau of Standards.

b. Amplitude

(1) An acoustic calibration of the system, including the microphone, should be performed in the field at least once every 5 days. The acoustic calibration should contain a reference signal of known amplitude and frequency in order to provide correlation with the calibrated sound pressure level. A pistonphone operating at a nominal 124 dB and 250 Hz is generally used. In addition, immediately before and after each day's testing, a recorded calibration of the system can be made in the field by injecting a 250 Hz sine wave signal into each microphone preamplifier.

(2) Each magnetic tape reel should contain a reference signal of known amplitude and frequency in order to provide correlation with the calibrated sound pressure level. The reference signal (which represents a known sound pressure level) is generated when the acoustic calibrator is in the proper position over the microphone or an electrical signal of known amplitude is inserted into the tape recorder.

14. COMPUTATION OF EFFECTIVE PERCEIVED NOISE LEVEL (EPNL). SPL data used in compliance demonstrations should be corrected to the airplane and environmental reference conditions prescribed in Part 36. Methods to determine a corrected EPNL at each measurement location for evaluating compliance with Part 36 noise level requirements are provided in this section.